Innovative Ways To Fight Insect Pests

If left uncontrolled, insect pests would eat or ruin about half of all crops grown in the United States. Insects and ticks that bite livestock cause discomfort, reduce production efficiency, and transmit important diseases like bluetongue and equine piroplasmosis. Biting pests are a threat to public health because they can transmit malaria, dengue, chikungunya, West Nile virus, and more.

New insecticides are constantly needed for all uses—crops, livestock, and public health—but companies tend to produce more new active ingredients for crops than for public health and livestock products, which have smaller markets and are more difficult to develop.

Several Agricultural Research Service (ARS) laboratories, in collaboration with others, are using innovative methods to find new insecticides for livestock and humans, particularly for our troops overseas. The search for safer, next-generation insecticides for the military and the public is being done in partnership with the U.S. Department of Defense (DOD) and industry. The Deployed War-Fighter Protection Research Program (DWFP) has provided funds and promoted industry collaborations and partnerships to advance this important initiative. Administered by the Armed Forces Pest Management Board, DWFP also funds a competitive grants program. While the DWFP program is specifically geared towards protecting our troops, the results can also be useful for the public and for agriculture.

Using DWFP funding, ARS's national program on Veterinary, Medical, and Urban Entomology (#104) has created a "virtual laboratory" from several ARS locations that have expertise in pesticide development. The virtual lab's activities include discovery, evaluation, development, and marketing. Our entomologists in Oxford, Mississippi, extract natural products for insecticidal or repellent activity, then perform a simple screening assay developed by ARS to prioritize the compounds. Our Gainesville, Florida, insect scientists screen thousands of compounds from chemical libraries and have invented new technology based on insect physiology. Our Beltsville entomologists apply synthetic chemistry expertise to chemically modify existing compounds and to invent new ones.

Gainesville scientists are working closely with the U.S. Navy Entomology Center of Excellence, Jacksonville Naval Air Station, Florida, to develop devices to make compounds more useful on a large scale outdoors.

Recently, ARS and the military have partnered with the IR-4 project to help with registration of products by the U.S. Environmental Protection Agency (EPA). IR-4 deals with registration of specialty crop pesticides but has only recently taken on the task of assisting us with registration of public health pesticides.

One of the important inventions to come out of this program is from Gainesville: the concept of molecular pesticides. These are short sequences of nucleic acids that normally regulate cellular synthesis of proteins. Designed to stop specific proteins, molecular pesticides can target particular pests, therefore sparing the environmental stress of killing all insects. These pesticides are persistent enough to be useful, but do not build up in the environment. Since the mode of action depends on the sequence of nucleic acids, there is hope that any insecticide resistance could be countered very quickly with a new mode of action.

Entomologists at Oxford have developed new, highly effective repellent compounds. These originated from American beautyberry, a plant that has traditionally been used to ward off flies from mules. They have also discovered an entirely new chemical class of insecticides by making extractions from fungal species that kill insects.

Beltsville researchers invented compounds that can be put into cuffs and collars of uniforms. Currently, uniforms are treated with a synthetic pyrethroid, but this only protects the skin directly beneath the cloth. Exposed skin nearby is fully susceptible to bites. The new compounds would create a barrier around the entire soldier, decreasing the need to apply inconvenient repellents.

But not every invention is a chemical. At College Station, Texas, ARS agricultural engineers have developed new ways to test equipment and evaluate pesticides and application techniques. At Gainesville, high-throughput systems developed there allow researchers to combine experiments with mosquito larvae, data processing, and structural analyses to quickly screen and test each chemical's potential as an insecticide. They have examined more than 2,000 compounds and found more than 200 to be effective against mosquito larvae and about 28 effective against adult mosquitoes. Gainesville scientists are also collaborating with the University of Florida to examine the U.S. Department of Agriculture's historical archives of insecticide data by quantitative structure-activity relationship modeling to predict and make new insecticides. This approach was used successfully to predict and make good repellent candidates.

STEPHEN AUSMUS (D2024-1)

Female boll weevil on a cotton flower. The pollen that sticks to her is a great forensics tool. See story, page 20.

Meanwhile, Beltsville scientists are figuring out exactly how repellent compounds work. It's exciting biology in itself, but these discoveries will be the key to the invention of truly innovative compounds that alter biting insect behavior.

Finding and developing novel compounds that kill mosquitoes is a long-term and worthwhile endeavor, with final registration dependent on successful completion of a large battery of EPA-mandated tests. Although the DOD-ARS insecticide development program is moving into only its second 5-year funding period, results so far indicate that several compounds with new modes of action show promise as future mosquito controls for the public.

Daniel Strickman
National Program Leader
Medical and Veterinary Entomology
Beltsville, Maryland